WHITE PAPER NO. 15 – FOXSIM MODEL DOCUMENTATION

Response to Comments by the Fox River Group

FOXSIM MODEL DOCUMENTATION

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ABSTRACT

As part of the public comments to the *Remedial Investigation for the Lower Fox River and Green Bay, Wisconsin* (RI) (RETEC, 2002a), *Feasibility Study for the Lower Fox River and Green Bay, Wisconsin* (FS) (RETEC, 2002b), and the *Proposed Remedial Action Plan, Lower Fox River and Green Bay* (Proposed Plan) (WDNR and EPA, 2001), the Fox River Group (FRG) submitted an alternate model entitled FoxSim, which "evaluates the on-going and future natural attenuation of the system" (FRG, 2002). FRG recommended the forecasts created by the FoxSim model be used over those in the *Model Documentation Report for the Lower Fox River and Green Bay* (MDR) (WDNR and RETEC, 2002). This White Paper briefly reviews FRG's modification of the model framework with respect to sediment dynamics and their representation of the physiochemical and biological processes of the Lower Fox River. It further briefly discusses the model results compared to site-specific data that has been collected, the initial polychlorinated biphenyl (PCB) concentrations and sediment thickness presented in the model input files, as well as the framework documentation that has been provided to the Wisconsin Department of Natural Resources (WDNR). Several of the parameters used in the FoxSim model are disputed. This White Paper concludes that the FoxSim model contains many uncertainties in its ability to predict PCB fate and transport in the Lower Fox River system.

REVIEW

The WDNR has reviewed the FoxSim model documentation provided by the FRG (FRG, 2002) as a part of the comments on RI/FS and the Proposed Plan. To this end, only a brief review of the FRG's extensive modification of the model framework (WASP4/TOXI4) with respect to sediment dynamics and their representation of the physiochemical and biological processes of the Lower Fox River in the FoxSim was possible. Furthermore, the evaluation of some aspects of the model performance could only be accomplished through actually running the model. The following discussions are limited to the brief evaluation of the model results compared to site-specific data that has been collected, the initial PCB concentrations and sediment thickness presented in the model input files, as well as the framework documentation that has been provided to WDNR.

Overall, it appears that the FoxSim model was developed to achieve the objective stated within the model documentation: to "evaluate the on-going and future natural attenuation of the system." A variety of model parameters applied in the FoxSim appear to characterize PCB-contaminated sediment in the Lower Fox River under a less dynamic condition. It may overemphasize sediment deposition in order to achieve the stated objective and hence fewer PCBs are predicted to be transported out of the River system. In addition, it appears that the input files under-represent the current level of PCB contamination in sediment as presented in the output of the Model Evaluation Work

Group as documented in the series of Technical Memoranda jointly developed by the WDNR and FRG modeling consultants.

The United States Geological Survey (USGS) collected water samples at the De Pere dam and near the River mouth for the analyses of PCBs during the 1993 high-flow event. The FRG model documentation did not present the comparison of the model results to the field data collected in 1992 and 1993 at the De Pere dam and the River mouth. The 1993 data was the only data captured under the "high" flow conditions during the model calibration period. If the comparison were made at the both sites, the model would under-predict the concentration by over 30 percent, the model performance goal established by the Model Evaluation Work Group. If the model can not accurately simulate the PCB concentrations in water column under high-flow conditions, it raises doubt as to whether the model is capable of accurately predicting the overall PCB mass transported to Green Bay. Another comparison that could be made that relates to the overall performance of the model is evaluating the FoxSim results in comparison with the data collected at the River mouth for the time period of 1994 and 1995. During this time period, no significant high flow events were recorded. Although the wind-wave-induced sediment resuspension was added into FoxSim, in addition to the flow-induced resuspension, the predicted PCB concentrations in the water column were much lower than the data showed, while the total suspended solids (TSS) matched well. The poor performance of the model in terms of PCB concentrations implies that PCB-laden sediments in the system were not accurately simulated in the model. Potentially, that means the buried PCB-laden sediment was not activated for transport.

Variation of initial concentrations presented in the model could influence the overall attenuation rates of PCBs in surface sediment. As described in the model documentation, the FoxSim model used the 1989–1990 data as the baseline and any data collected after that period were projected backward based on an assumed declining rate with a 10-year half life. This is inconsistent with the procedures agreed to by the WDNR/FRG joint Model Evaluation Work Group and in addition, the application of this interpretation method ignores the fact that the 2000–2001 data presented by the FRG shows an increase of PCB concentrations in surface sediment at some of the locations downstream of the De Pere dam (FRG, 2002). The result is an underestimation of the initial sediment PCB concentrations. Consequently, the results of the long-term simulation of the no-action alternative would be biased low with the surficial sediment PCB concentrations being less under a natural attenuation scenario, while the benefit of active sediment remediation would be reduced.

Another parameter as presented in FoxSim that can have a long-term effect on the model prediction of PCB concentration was the sediment thickness. For upstream of the De Pere dam, the sediment deposits were seemingly arbitrarily presented as 300 cm thick even in the areas where Technical Memoranda developed under the Model Evaluation Work Group and actual field data indicates no soft sediments exist at such depth. For downstream of the De Pere dam, the Sediment Management Units (SMUs) were seemingly arbitrarily limited to 30 cm thick while field data and the Technical Memoranda document contaminated sediment at depths in excess of 300 cm exists in this River stretch. The obvious effect by including deep clean sediments (even non-existing)

in the upstream and excluding the highly contaminated sediments downstream, in the long term, for instance 100 years, is that the model projects the transport of clean sediment from upstream and the subsequent deposition of it downstream. The result is the projection would be a demonstration that contaminated sediment in the last 7 miles of the River is buried faster and deeper. Although the precise magnitude of the effect of the vertical sediment thickness on the long-term model simulation can not be evaluated without running the model, based on historical data, as well as that presented by the FRG in their comments, this is clearly not a true representation of PCB-contaminated sediments in the River. In addition, it may well reduce the release of buried PCBs from sediment to the water column and hence being transported to Green Bay.

Additionally, some of the sediment deposition/scour rates simulated by the FoxSim model, as described in the Exhibit 9 (FRG, 2002), were unrealistic. According to the FoxSim model over the 100-year course, some of the areas of the River will be filled with sediments and become upland or island while in other areas a 1-meter deep hole will be created.

In summary, the FoxSim model contains high uncertainties in its ability to predict PCB fate and transport in the Fox River system. The model was constructed with a stated bias to "evaluate the on-going and future natural attenuation of the system." This is accomplished through the model's prediction of deposition of clean sediments and less scour of contaminated sediments, which leads to a prediction of less availability of PCBs to the water column and transport of PCBs within the River, and from the River to Green Bay.

REFERENCES

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